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The Photo Miniature

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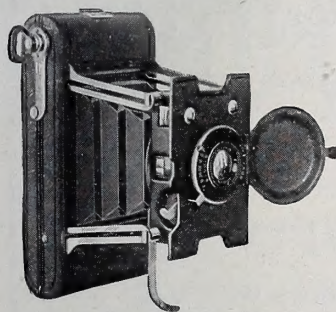
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The Photo-Miniature

A Magazine of Photographic Information

EDITED BY JOHN A. TENNANT

Volume XIII SEPTEMBER 1916 Number 153

Optical Notions for Photographers

In photography, as in any other craft, we cannot know too much of first principles. For one thing, the study of them is a fine education of the mind; for another, we are prevented from making stupid mistakes—from doing things we should never dream of doing if we perceived clearly the broad elementary facts which lie at the bottom of the processes or apparatus we use. And still another reason is the entrance which we thereby gain to other and wider fields of knowledge, the boundaries of which no man can define since they are continually being extended as unknown facts of Nature become known.

I cannot pretend to escort the reader very far in the most fascinating field of light, yet I believe the adventure will be found altogether interesting. Certainly it will not be without profit in every-day photographic work, without which assurance I should hardly care to ask the reader to make a journey somewhat off the beaten track of these monographs. But I can promise that our excursion, as I have planned it, will bring us into contact with facts which have to do with every-day photography, and that at the end we shall be in the happy frame of mind of, say, some business man who has made a pleasure-trip over half a continent and has brought back a sheaf of orders into the bargain.

So much for the dual purpose of these pages. Now let me say a word of their subject matter. Photography, as we all know, belongs to the regions of both chemistry and that branch of physics concerned with light. In a narrow sense it is based upon the chemical action of light. But in making photographs we carry out many chemical operations which have nothing whatever to do with light, and equally we have occasion to use and control light altogether without concern for its chemical action. Readers of *THE PHOTO-MINIATURE*, Nos. 18 and 149 will have gained some insight into the chemical principles and processes, but I cannot recall any photographic manual in which an attempt has been made to explain in plain English the elementary properties of light. These are of prime importance, however, in almost every branch of photography. It is true we have books on lenses, such as *THE PHOTO-MINIATURE*, Nos. 1, 36, 79, and 140, but they deal only with the part played by light and the lens in forming the image on the plate or film. In the present monograph, written and illustrated with painstaking and enthusiastic care by Mr. George E. Brown, we get back to first principles. Moreover it seeks to deal with real things, whereas authors of treatises on optics almost habitually write of things which happen only in books, passing over many things which happen in practice, solely for the reason, so it would seem, that they cannot be expressed except in formulæ which few can understand.—EDITOR.

Sources of Light

From whatever source it comes, the unclouded sun, a dull sky, or any flame or lamp, light follows the same laws. Some of its properties vary according to its origin—these are chiefly its color and degree of diffusion—but essentially it is the same and behaves in the same way in the changes it undergoes by reflection and absorption, on passing through transparent or semi-transparent substances, and when subjected to control in this or that optical instrument.

Its behavior is the same for the reason that light, however produced, has, on good grounds, been judged to be a wave-motion on an ultra-microscopic scale,

not of the air but of a far finer medium (ether), assumed to exist and to pervade all space and every substance. In other words, light is conceived to consist of innumerable minute wavelets measuring 40,000 to 60,000 to the inch, and moving in this elastic ether. The ether as a whole does not move, but extraordinarily minute movements up and down, sideways, etc., in it create the wavelets which traverse it and produce the effect of light.

Unfortunately it is not possible in this monograph to treat the facts of light in the terms of this wave-theory. To do so would entail diagrams beyond our space and mathematics probably in excess of the reader's inclination. But light can be so treated, as it is, for example, in Prof. R. W. Wood's magnificent book "Physical Optics," in which, scattered among stiff mathematics, you will find a host of experiments, including many which come from the author's fondness for photography. But though we leave the wave-theory for the most part on one side as a vehicle of explanation, let it not be thought that it is thereby relegated to the category of doubtful things. Although these minute undulations of an imagined ether are outside human ken, so much is known of them that they rank with steam or the electric current among the things which admittedly exist even though they cannot be seen and handled.

But to return. Here we shall seek to recognize the points of difference and resemblance which characterize light from different sources, and shall endeavor to gain our knowledge by way of the use we make of light of one kind or another in practical photography.

One feature, common to light from every source, is that it travels in straight lines. It takes a straight course which can be modified only by doing something which will put it on a second straight-line path making an angle with the first. As a matter of daily observation we know that rays of light do not follow a curved course like a stream of street traffic or a projectile in flight. All optical instruments, lenses, telescopes, and sextants are based on that fact, and the science of geometrical

Light in Straight Lines

optics is concerned with the study of light on this basis as distinguished from physical optics which starts with light as a minute wave-motion and arrives at the same laws by a different train of reasoning. Here we shall follow the former plan since it lends itself much better to the explanation of the elements of the subject.

One of the consequences which follows immediately from the fact of the straight-line course of light is that the position of one object with regard to another, placed somewhat in front of it, changes with the position of one's eye. Apparent shift of this kind is called parallax, and is the cause of various errors in observation, inso-

much that the term is most frequently met with in connection with mistakes due to rays reaching the eye obliquely instead of "square-on." A common example is the setting of the pointer on the graduated focusing-scale of a hand-camera. In Fig. 1 the distance of the pointer A above the scale is exaggerated. The ray of light proceeding directly upward from the mark B and just grazing the pointer, meets the eye when it is placed as it should be, exactly overhead at D. But if the eye is placed to one side or the other, as at E, it is the ray from C which meets it. The mistake is one

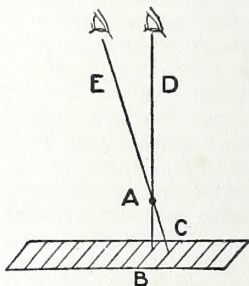


FIG. 1

of parallax and is liable to be more serious the greater the space between the pointer and the scale.

**Parallax in
Color
Processes**

This parallax error creeps in in other ways, for example, in color photography by a process such as the Paget where a plate consisting of minute color elements is united to a positive transparency obtained from a negative made through a similar color-screen. I would refer the reader to THE PHOTO-MINIATURE, No. 147, "Color Photography." Fig. 2 shows what happens in the case, for example, of a green patch in the picture produced by blocking out the

blue and red element by the deposit on the diapositive. So long as rays pass straight through the two films (Fig. 2) there is no disturbance, but if the eye is placed so that rays passing obliquely reach it there is bound to be falsification of the colors due to the rays passing



FIG. 2

through parts of adjoining color elements. This effect arises to some extent with color film and diapositive in one owing to the thickness of each layer, but it is more pronounced when the two are separate glass plates since it is practically impossible to bring the two surfaces into absolute contact. My diagram shows why the latter kind of transparencies show false colors unless means can be taken, as when projecting them in a stereopticon, to cause the light to pass through them at right angles to the surface. Parallax, it should be added, is not always a troublesome phenomenon: some years ago Mr. F. E. Ives applied it very ingeniously to making stereoscopic or relief photographs requiring no viewing instrument for the exhibition of their illusion of relief.

A further consequence of the straight-line path of light-rays is the rule of relative intensity of illumination of surfaces at different distances from a source of light of small area, a matter of every-day moment in making contact prints on development or gaslight papers. In Fig. 3 the lines represent the extreme rays falling on the small square surface A from the candle. Imagine this square taken away and the light to fall on a surface B at twice the distance. It is clear that the area of this surface is four times that of the square A, and as the volume of light is the same—the second surface does not receive any more rays from the candle than

the first square did—the intensity of illumination is one-fourth. Similarly, at three times the distance the intensity of illumination at every point of C is one-ninth and at four times the distance one-sixteenth. In other words, a printing-paper which, under a negative, requires 1 second exposure at A, will require 4, 9, or 16 seconds' exposure if placed at B, C, or D, respectively.

This is the law or rule of inverse squares so often referred to in books about enlarging, viz., that the intensity of illumination varies inversely as the square of the distance from a small source of light, that is to say that photographic exposures will vary not inversely but directly as the square of the distance from the light.

Inverse-Square Law

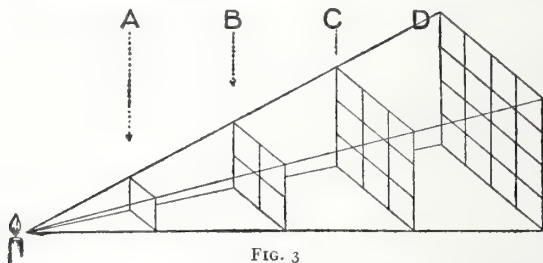


FIG. 3

There is no need to be frightened by the term "square." It is simply the distance multiplied by itself and written, for short, distance² e.g., 2^2 , 3^2 , 4^2 , = 4, 9, and 16 respectively. It means that if the exposure at 2 feet from the light source is 6 seconds, that at 5 feet will require to be $6 \times 5 \times 5 \div 2 \div 2 = 37\frac{1}{2}$ seconds.

But look again at Fig. 3 and you will notice something about it. The light proceeds from a point. The law holds good only when the light emanates from a minute source. But usually the light is not very small. It is generally a lamp-flame, gas-mantle or electric bulb of size very likely as much as a quarter the distance of the printing-frame from it.

If that is so, the inverse-squares law no longer holds

good, and it is not possible to say exactly how the intensity of illumination at 2, 3, or 4 feet distance compares with that at 1 foot. The reason for this is that the rays from every point in such a light-source spread out like those from a bit of the candle flame in Fig. 3. Instead of one set of rays all diverging from one point, you have innumerable sets diverging in all directions from the light-source, the rays of one set overlapping those of another when they fall on any surface a little way off.

In these circumstances it is not possible to state a general rule for the falling off in the intensity of illumination: any rule depends on the size and shape of the light-source and its distance from the surface. Also the illumination is usually not uniform unless the source of light is as large as, or larger than, the surface to be illuminated. As regards the lights we have mentioned, the only rough idea I can give for distances up to, say, 3 feet from the light is that the illumination is inversely proportional not to the square of the distance but to the distance alone. In other words the exposure required at 2 feet and 3 feet will be twice and three times that at 1 foot, not four times and nine times.

Where
"Square" Rule
is Null

But even when the source of light is almost a point, e.g., an electric arc, the inverse-square rule may cease to apply. Not theoretically, but practically. Suppose

your light is a long way off, say 30 feet. Then a position a foot or two further away will make relatively very little difference. At 33 feet the exposure will be only one-fifth more than that at 30 feet since the squares of these two distances are 900 and 1089, and are in the proportion of practically 100: 120.

A difference of 20 per cent in the exposure of printing-papers is not enough to have any appreciable effect. If you think, you will realize that at such considerable distance from a small source of light, the rays, if one considers only a short length of their path, are almost parallel. Therefore, within the limits of this length the illumination does not vary materially. If the light-source is at an immense distance the light-

rays are to all intents and purposes parallel. If they are parallel, our inverse-square law does not apply at all and the intensity of illumination is the same whatever the distance, except in so far as the light may be absorbed in its passage through the air.

The use of a lens which renders parallel the diverging rays from a source of light is the method employed to secure a beam which illuminates as strongly at 30 or 50 feet as it does at 2 feet. This is the system of the light which, from the gallery of the vaudeville hall, follows the star lady on the stage. The rays if not perfectly parallel are very slightly divergent. The lenses in these theatrical light-boxes are of curvature to yield a cone of rays of very narrow angle. Over a short distance the rays are fairly parallel.

**All-round
Illumination** It must be remembered that in the foregoing paragraphs we have considered only the rays coming in one direction (horizontally) from a source of light. But most light-sources emit rays in many directions—toward an imaginary sphere or globe at the center of which the light is supposed to be. The illumination from any light-source, except supportless incandescent globes like the sun, varies very greatly in different parts of this imaginary sphere, and lamp-makers now measure the distribution of light by their bulbs or mantles and can supply charts or figures showing exactly what it is. This is too wide a subject to pursue further—the reader must refer to text-books on illumination—but it is not without its practical importance.

For example: The electric bulbs which are fitted into the printing- and enlarging-boxes now so much used will behave very differently as regards the light they send to the negative, according to the way they are placed. There will always be one part of the imaginary sphere surrounding the lamp which gets the best illumination, and the lamps should be mounted so that the negative comes in this portion of the spherical field. A year or two ago, a lamp specially designed for emitting its rays chiefly in the direction of the end of the bulb was placed on the market. The filament

extended gridiron fashion across the bulb instead of lengthways as usually. I found that exposures were one-fourth those required with a lamp of the usual pattern and equal candle-power also placed with the tip pointing toward the negative. Obviously the ordinary pattern of bulb should be used with its filaments as nearly as may be parallel with the negative, yet one often sees printing-boxes fitted with the usual lamps, end on, in disregard of the fact that electric bulbs are not miniature suns but scatter their illumination in different directions very irregularly.

So far we have been concerned with the distribution of light directly from its source. Now we must come to consider what happens when light falls on different objects. These happenings are various. There is reflection, with which we are familiar enough, and absorption, which we are apt to overlook. In passing through substances, light also undergoes other changes which play a very important part in photography. The behavior of light in these various ways will again be found to bear directly upon the processes and appliances employed in making negatives and prints.

Reflection of light takes place in various ways according as the reflector is a polished or matt surface, is opaque or transparent. The reflective action differs, first as regards the quantity or proportion of light reflected, and second as regards the direction (or directions) which the reflected rays take. When light falls upon any body three things can and do happen. Some of the light is reflected, some is absorbed and disappears, and some, if the body is more or less transparent, passes through. In looking more closely into these matters we will take first the action of flat polished reflectors since this differs radically from that of matt or rough surfaces such as paper or walls.

A substance of flat polished surface, such as plain glass, burnished metal, or glass with metal deposited on it, reflects light in a definite way, referred to in the text-books as "regular" or "specular" reflection. If the

light strikes the reflector squarely, at right angles to the surface, it is reflected straight back again along the path by which it came. But if the light falls on the surface at any other angle than a right angle, each of the rays which make up the total volume is reflected at the point where it impinges on the surface according to an invariable rule illustrated in Fig. 4. A ray from A meets the surface at B. From B imagine a line, BE, drawn perpendicular to the surface. Then the distance of the reflected ray BD is known from two facts:

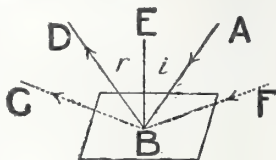


FIG. 4

(1) It lies in the same "plane" (that is an imaginary thin surface) as AB and BE and (2) it is inclined to the perpendicular BE to the same extent as is AB. All reflection from polished surfaces follows the two-in-one rule, which is expressed by saying that the angle of incidence, ABE, is always equal to the angle of reflection, EBD.

But remember that that alone does not fully describe the law unless it is understood that the reflected ray lies always in the same plane as the incident ray. If the nature of light did not compel it to remain strictly in the same plane—it is a necessary consequence of wave-motion—it could strike off in any of a thousand different directions all angled to BE as AB is, and there would be no such thing as regular reflection. As it is, the reflected ray has always this definite relation to the original ray whatever the first direction of the latter. If it is more oblique, as shown by the dotted line FB, the reflected ray is BG; the angle FBE is equal to the angle EBG.

A homely example will remind you
An Illustration that this definite law of reflection is true. On a day of brilliant sunshine you will sometimes see flash out a patch of intense light from a distant window or polished face of a clock as you happen to come into a certain position. You have only to move a little away for the effect to vanish. You came into the path of light traversed from the

reflector which anywhere else at such a distance is invisible. If all objects reflected light only and solely in this way we should be able to perceive things only from certain definite positions, but, as we shall see directly, light is reflected in another way which permits of objects being viewed wherever we may be.

Now what is the consequence of this definite and rigid law of reflection? It is that a polished surface reflects light not merely in any jumbled fashion but a ray for every ray which falls upon it. One might think from this that if you held up a mirror before any scene or object you could reflect an image of the latter onto a screen. But a mirror does not *form* an image in this way. What it does do is to *show* an image which you can see or photograph "in the mirror" though you cannot reflect it onto another surface. If we take the trouble to consider the reason for this it will serve incidentally to make clear some of the points connected with the action of the photographic lens.

Figure 5 is a diagram explaining how the bright picture or reflection which we see "in a mirror" is formed. MM is the mirror and A some minute object facing the mirror-surface. What is happening when we look at

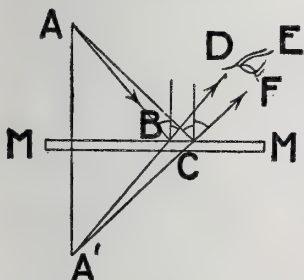


FIG. 5

the mirror and see the object A apparently behind MM? Clearly it can only be that the rays from A are reflected back by the mirror to our eye wherever it may happen to be, say at E. We know that an object, whatever it is, emits light in all directions. It will be sufficient to see what happens to two of them, AB and AC,

which strike the mirror at B and C. As we have just learnt, each is reflected so that the angles which the reflected rays make with imaginary perpendiculars are

respectively equal to angles which the direct rays make with the perpendiculars. By drawing lines on this basis you get the reflected rays BD and CF. You notice that they are not parallel since the ray AC is more oblique than AB. Now lay a straight edge along each in turn and continue each until they meet. If you have done your drawing of lines and angles correctly you will find that the point A^1 where the continued lines meet is exactly opposite A, and that A and A^1 are at the same distance from the reflecting surface. In other words, the rays which we know reach us from A by reflection at B and C appear to come from A^1 . Though the rays from A^1 have no existence the effect on the eye is as though they did exist. They are what opticians call *virtual*. It is as though the object A had been transferred to A^1 , and that applies to every other minute object forming a scene near or distant and to any position of the eye from which the mirror can be seen. The image (virtual) is as far behind the mirror as the object is in front of it. This is the principle of the old dodge of judging the thickness of a mirror silvered on the back by laying a coin on the glass surface and estimating by eye the distance between it and its reflection. This distance of course is half the thickness of the glass.

**Not a
Real Image**

From the foregoing it will be clear that a mirror does not form an image in the sense that a photographic lens does. All it does is to form an optical same-size illusory reproduction of an object in a plane which seems to be behind the mirror. It forwards the rays to the eye exactly as they would come from the original scene—except in one respect referred to in the next paragraph. It does nothing to bring to a focus or point all the rays which come from every point in an object as a lens does in forming a real image—our eyes do that when we look at a real thing or a mirror-image—but it must not be forgotten that a mirror, if interposed in the path of rays from a lens, reflects them, also, according to the definite law of page 374 (Fig. 4). It can reflect the rays forming a real image and is widely used for that purpose in optical instruments.

Reversal by Mirror

But the image we see in a mirror differs from the original object in one important respect. It is reversed as regards right and left. That this must be so will be clear if I repeat the diagram Fig. 5 in a rather more elaborate way, show the formation of the mirror-

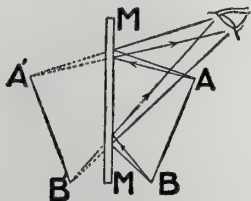


FIG. 6

image not of a point but of an object of definite shape, e.g., a line AB. To construct the image it is sufficient to apply the previous method to the points A and B. The reader will see that it is exactly that of Fig. 5. It shows why, when viewing the image, A^1 is on the right and B^1 on the left, whereas, when taking a front

view of the original object, A is on the left and B on the right. This action of the mirror is exerted equally when it is applied to the rays from a lens, causing an image or a negative to be reversed right for left and *vice versa*.

Unwanted Reflection

Unwanted Reflection Well, now what of the application of these properties of a polished reflecting surface in practical photography? They are not far to seek. I have space only for two or three, the purpose of this manual being to explain principles to be applied by the reader himself. But one or two examples are worth while by way of showing that the principles must and do govern all practical work. Take for instance the photographing of a painting, the glass covering of which, or even the varnished surface itself, acts more or less perfectly as a mirror. Reflections are in fact the bane of those engaged in taking photographs of paintings in public galleries where the conditions of lighting usually make it difficult to avoid them. What are those conditions? The painting is usually placed near to a window or is photographed in its permanent position on the wall. In either case, it is almost always exposed to rays from the outside sky or from light parts of the gallery. These rays are reflected in directions which depend upon the angle at which

they fall upon the painting or its protective glass. Our law of page 374 (Fig. 4). According to the particular circumstances a large or small proportion of them form the whole or part only of the picture, impinge on the lens, and produce excessive action on the plate. The effect is the unsightly glare to be noticed in many photographic copies of paintings.

A knowledge of the law of reflection enables the photographer frequently to avoid this defect altogether, e.g., by covering up part of the window, by erecting a screen to cut out the rays, or more simply still by slightly angling the painting to the camera or *vice versa*, so that the reflected rays do not travel to the lens. In cases where the light which is thus harmfully reflected to the lens comes from behind the camera—to one side or the other—an old device is to erect a large black curtain just in front of the camera with a division in it for the lens to poke through. In order to have this curtain of the most advantageous size, Mr. Cameron-Swan, a leading professional photographer of paintings, calculates its size in accordance with the law of reflection from a polished surface and finds that a screen a little more than twice the linear dimensions of the picture to be copied, placed just in front of the camera, serves to cut out all the rays from the rear which can be reflected into the lens. Anything larger than this only intercepts light which might usefully (not harmfully) illuminate the painting.

Useful Reflection A different requirement arises in cases where we want to reflect all the light we can. For example, a mirror is often used to direct the light from the sky through a negative which is being enlarged with an apparatus evolved from the worker's camera. The window of a room is closed up with the exception of a space where the negative is placed and the mirror (outside) is angled at 45° . A similar plan is followed in printing-boxes, using gas as the illuminant, the light being reflected upward through the negative by a mirror again at an angle of 45° . In such cases the law of page 374 tells us at what angle to set the mirror, but it requires to be remembered that the regular reflection

from a polished surface may really be less effective than a matt reflector like paper which, as we shall see directly, acts in a different way. This is because the polished

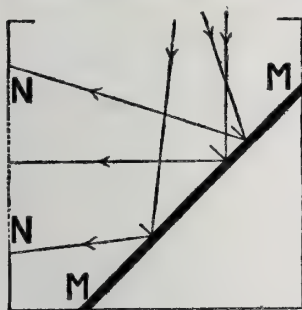


FIG. 7

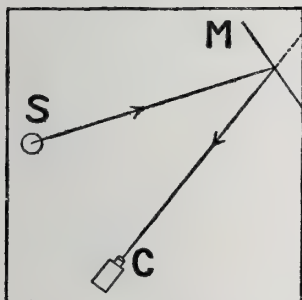


FIG. 8

surface is called upon to reflect rays which reach it at all degrees of angle. Hence it will reflect many rays in a direction along which they never reach the negative. Fig. 7 illustrates this point, NN being the negative and the lines showing the subsequent paths of rays falling on the mirror MM at different angles.

Generally speaking, a polished surface is less efficient and in other ways less suitable than one of matt surface as a means of illumination unless all the rays which fall upon it are parallel. On the other hand, it is hardly necessary to point out that a reflector for use in altering the course of rays from a lens requires to be of the highest polish and optically flat. If it is not, the

image will suffer in brilliance and definition, respectively. The mirror of a reflex camera needs to be of this kind in order to secure easy and accurate focusing.

Mirror and Wide-Angle Lens

We learned in a previous paragraph that the image formed by a mirror lies as far behind the latter as the image is in front. Where a large mirror is available the fact can be easily applied to obtaining photographs in places where otherwise a wide-angle lens would be necessary. The use of the mirror vir-

tually doubles the distance between the subject and the camera. Fig. 8 shows the arrangement. The subject *S* is photographed as though actually at *S*, the position of the camera *C* requiring to be chosen so that the apparatus does not come in the image formed by the mirror *M*. The negative so made is of course reversed as regards right and left.

Reflective Power

So far we have been concerned solely with the directive action of mirrors, but a word requires to be said on the relative reflecting powers of substances used as mirrors. No surface reflects the whole of the light falling on it. Some is absorbed; some is diffused, that is reflected, not in one definite direction but in all directions (see later, page 382). The proportion of light reflected in this latter way depends on the extent to which the surface is deficient in polish. Of the surfaces used as mirrors, that of silver (deposited on glass) is the best reflector, sending back, according to the law of regular reflection, about 96 per cent of the incident light. Polished plates of steel or copper reflect much less light though they have been used to some extent. According to a high German authority, the best metal for a mirror is an alloy consisting of two-thirds copper and one-third tin with a little arsenic. Ordinary looking-glasses with the coating on the back surface are prepared with a mixture of mercury and tin.

Transparent Reflectors

Thus far we have been considering reflecting surfaces like metal or silvered glass which are opaque. But a substance need not be opaque to be a reflector, although the reflective power of transparent bodies is very much less for the simple reason that much of the light is transmitted. But a little study of transparent reflectors will bring us in contact with a fact not hitherto encountered.

Both Surfaces Reflect

This fact is that reflection takes place from the back as well as from the front of a transparent reflector. Lay the rim of a coin against an ordinary mirror which is fairly thick glass with a reflecting coating on the back. Besides the full-strength reflected image a little way

back, you will see a much paler image touching the coin and therefore showing itself to be from the front surface of the glass. A piece of plain glass behaves in exactly the same way and is best seen—as the effect is much weaker—by holding a lighted match an inch or two from the glass and viewing the latter from one side: the two virtual images will be plainly seen one behind the other. In short, reflection takes place according to our rule of page 374 from the back surface of a transparent reflector just as from the front, except that the course of the reflected ray is further modified by the bending or refraction which it undergoes when it passes from one medium to another, in the present instance from air to glass and back again from glass to air.

Surface-Silvered Reflector It is on this account—the reflection from each surface—that for critical purposes a mirror requires to be a single surface, that is to have the

reflecting coating on the front of the glass instead of the back. The optical firms call this “surface-silvered.” The mirror of a reflector camera ought to be of this kind though in some cheap makes the reflecting coating is at the back of the glass. If the latter is thin, a mirror of this kind is possible because the reflective power of the metal coating behind the glass far exceeds that of the plain glass surface and therefore the image reflected from the latter is too weak to interfere with that from the former in focusing the subject. Also the back reflecting surface is sealed between the glass and a backing varnish and does not lose its brilliancy by exposure to the air as a surface-silvered mirror does. But if the mirror is to be used for reflecting the lens-image on to a sensitive plate, a surface-silvered mirror is essential in obtaining sharpness. The mirrors used by photo-engravers for obtaining reversed negatives in the camera are therefore surface-silvered, and are sometimes protected from tarnishing by a thin coating of celluloid varnish. Surface-silvered mirrors of this sort are also used, for the same purpose, in many applications of science in every day life.

Although the reflective power of a transparent surface is small—plain glass reflects only about 4 per cent of the light falling on it—it is sufficient to give rise to the unsightly defect of halation met with in making negatives on glass plates of subjects the bright parts of which come immediately against those which are darker. Patches of sky among tree branches, the windows of an interior subject, are familiar examples. The halation arises chiefly from reflection of rays, which have come through the emulsion film, by the back surface of the glass plate. This reflection causes them to return along a different path and thus to produce an extra and false effect, on parts of the film surrounding the image of the bright portion of the subject. Refraction as well as reflection plays a part here, so that I must postpone a study of it until we have dealt with the former (see page 389).

Diffused Reflection When light falls upon a matt surface like unglazed paper it is reflected, but for the most part not at all in the way in which it is reflected from a polished surface. Each bundle of rays, instead of leaving it at the same angle at which it met it, passes off as a number of rays diverging in all directions. This is called diffused reflection and is the effect produced by the great bulk of natural objects upon light which falls on them. The precise inward cause of it does not appear to be certainly known. It would seem not to be entirely due to the different angles which even a surface which is smooth to our eyes presents to waves of the minuteness of those of light: the action is supposed to be connected also with a partial penetration of the waves into the particles of the substance and their reëmergence in all directions.

Whatever may be the cause, we owe to this diffusion of light our ability to see objects from all positions, not merely from one place as in our example of the window, page 374, foot. Stupendous as the idea seems, we must imagine countless rays of light proceeding in every conceivable direction, each along a straight-line path, from every point of every object. Only by

conceiving such a condition as this can it be explained how it is possible for the eye or the lens to form an image of a scene. The whole of the light is not reflected in a diffused condition. Some, a very large proportion of the substance if it is dark, is absorbed. Some, also, according to the degree of glossiness of the surface, is reflected regularly as by a mirror. But the major proportion is scattered—up, down, sideways. You can have no better example of the action than the dark letters you see on the ground against some shop window with lettering painted in the glass. In sunlight the ground receives extra illumination by rays regularly reflected from the glass, but the painted lettering scatters the light and thus causes the form of the letters to be recorded as darker areas on the ground.

**Diffusive
Reflectors**

In practical photography, however, we want to use surfaces which reflect light entirely in a diffusive way and therefore it is interesting to remember that ordinary white blotting-paper, such as Photo Finish World, possesses this property, rivaling in this respect freshly fallen snow. According to the most accurate measurements available, the proportion of light reflected is 82 per cent. It is probably impossible to get a better material, certainly not one which is cheaper and more easily renewed, for the purpose for which diffusive reflectors are used, viz., even illumination.

This leads me to touch again on a point already briefly referred to in speaking of reflection from a mirror (page 378). If you look again at Fig. 7, you will realize that the action of a reflector of white blotting-paper differs from that there represented in that each direct ray is not reflected along a certain definite path, but is broken up into innumerable minor (i e., feebler) rays going in all directions. Fig. 9 illustrates this difference by showing the diffusion of light from only one narrow pencil of rays. Imagine this action to be taking place from every particle in the surface of the blotting-paper and you will understand that the illumination of the negative differs from that from a mirror in the fact that rays of light fall upon it and pass through it at

every conceivable angle, in other words, in a "scattered" condition as distinguished from one in which the rays come in much fewer directions. The result is more even illumination, particularly if the prime source of light (e. g., an electric or gas lamp) is comparatively near to the reflector. A mirror would never do in those circumstances. Moreover, for certain purposes this more or less complete scattering of the light in enlarging a negative is a good thing. We will come to that in a moment, but here we just note that the blotting-paper reflector can well be a good deal bigger than the negative in order to provide a supply of oblique rays. There is a limit to its useful size because the illumination falls off as the rays become oblique and at an angle of 30° to the reflector they are only one-half the intensity of those which proceed perpendicularly to the surface.

Diffused Transmission As the reader knows there is another way of illuminating a negative evenly, namely, by sending light to it along a direct path, at the same time interposing a diffusing screen of ground glass or opal. In other words we diffuse the light by transmission instead of by reflection, as in the illuminating system of enlarging apparatus. The result, so far as the nature of the illumination is concerned, is pretty much the same. The passage of the light (daylight or an artificial source) through the diffusing screen has the effect, as it were, of creating a fresh source of light from which rays proceed in all directions as they do from blotting-paper. At the same time a large proportion of the light is absorbed by the screen. Rays which pass through no longer follow their original course but are broken up into feeble radiations which scatter in all directions from each point of the screen. The behavior of light in this way proves sometimes useful and at other times harmful in photographic work. Perhaps one or two examples will serve to fix the significance of this in the reader's mind.

Darkroom Illumination Take such a simple matter as the illumination of the darkroom. Until a few years ago it was the rule to use clear ruby or orange glasses in the darkroom lamps. It was

not recognized that comfortable working is all a matter of striking a balance between the intensity of light which is without action on the plate within a reasonable time and that which produces a sufficient effect upon the eye to give the desired illumination. You get one at the expense of the other, and that applies to light of any color which the color-sensitiveness of the plate may require. One evil feature (among others) of the old clear glasses was that they allowed the concentrated rays from the light in the lamp to reach the eye, producing glare and diminishing the ability of the eye to see in the weak illumination.

The improvement came by stealth about ten years ago, for Dr. Mees, to whom our modern really safe "safelights" may be credited, found it convenient to use paper as a vehicle for some of his dyes in making them. But you will realize that with a light which distributes itself diffusively, glare is enormously reduced, and the physiological relief allows of lesser and safer illumination being used with equal comfort. It is, in fact, a maxim in the modern science of illumination in workrooms, stores, factories, etc., not to expose the

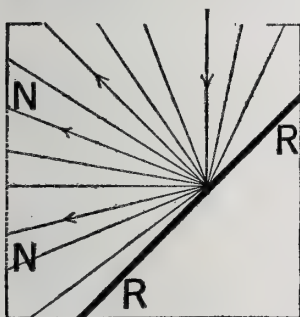


FIG. 9

eyes to undiffused light but to use a reflected or diffused light. This principle surely applies in the photographer's dark-room more than anywhere else.

The alternative to diffusion by the safelight is to put the light itself out of sight and transmit its rays by a diffusive reflector (Fig. 9). Dr. Mees did in fact embody both methods in

1907 in the darkroom lamps designed by Mr. Wratten.

Now see another effect of this scattering of light, namely in affecting the kind of enlargement one gets from a negative. It needs no demonstration to realize that a

**Diffused Light
in Enlarging**

negative is itself a semi-transparent material which transmits light diffusively. Its diffusive action is obviously dependent on the grains of silver in the gelatine film and therefore is greatest in parts having the heaviest deposit (the high-lights of the subject) and least or *nil* in the clear (shadow) portions.

This "scatter" of light from negatives has long been recognized, but it was the Belgian experimenter, M. André Callier, who first pointed out how it is the very simple cause of an enlargement being harder in contrast than a contact print from the same negative. Fig. 10

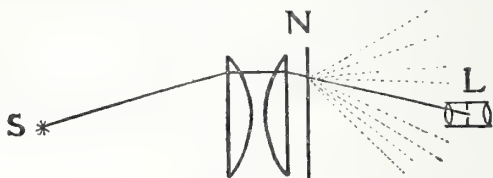


FIG. 10

is Callier's diagram showing how, in enlarging with a condenser lantern, a given ray from the light-source S, follows a definite path through a clear part of the negative N, to the lens L. But if, on the other hand, it meets a more or less heavy deposit in the negative, it is scattered, as roughly shown by the dotted lines, and hence much of the light which should be transmitted by this minute area of the negative does not reach the lens at all. Thus the shadows of the negative produce too much light-action on the bromide paper in comparison with the heavier deposits, with the result of increase of contrast.

In contact-printing, with the paper right against the film of the negative, there is no opportunity for this scatter of light rays, which therefore at every point produce an effect on the paper in accordance with the density of the negative.

In enlarging, the preventive of this hardening of gradation is to illuminate the negative by light which is completely scattered beforehand. M. Callier does this by dispensing with the condenser and placing a sheet of opal glass in contact with the negative. From

this brief description it will be understood that, apart from the quality of the paper, perfect diffusion of the light is a factor in making enlargements of contrast corresponding with that of the negative, which may account for the efficiency of the little Kodak Illuminator designed for enlarging from small negatives. It is also, no doubt, for the same reason, a reliable means of avoiding over-emphasis of retouching marks on negatives, or of the relief of carbon transparencies, when enlarging either of these.

**Enlarging
Boxes**

In enlarging by artificial light with bought or home-made apparatus, other than condenser lanterns, the illumination is diffused, as a rule, partly by reflection, partly by transmission. The two together are so effective that it is possible to include also the direct rays from the light-source as, for example, in the illuminator for the Brownie enlarger. Remember here that the effectiveness of the light by reflection depends on the whiteness and mattness of the reflector: more on these than upon its shape. Makers of some apparatus suggest that a matt reflector of paraboloid curve sends parallel rays through the negative. It does so of course only to a very slight extent: the chief part of the light is scattered. As regards the scatter by a diffusing-screen, the nearer this latter is to the negative the better.

**Light-Scatter
in
the Camera**

Nevertheless this same scatter can act inimically. (A good word, but unfamiliar. It means hurtfully or adversely.—ED.) A film of dust or moisture on the back surface of a lens forms a diffusive surface, causing a proportion of each ray which should proceed along its definite path to form the image to scatter in all directions. The result is that the plate receives a certain light-action uniformly over its surface, apart from the direct image-bearing rays, and thus yields a flat or even a veiled or fogged negative. The defect is more pronounced when the lens faces the sun more or less directly, but in any circumstances it is a common cause of lack of brilliance in negatives. It is also caused by the reflection of light upon the plate from the interior of the camera when a large lens is used.

**Absorption by
Diffusing-
Screens**

It must not be supposed that the whole of the light which falls upon materials like ground-glass or opal is transmitted in a scattered direction. A little probably passes on, as though the screen were perfectly transparent, but a relatively large proportion is absorbed. Figures for the relative amount absorbed are very approximate since the surfaces and thicknesses of the materials are very various. The following are the percentages of light absorbed by the materials mentioned which are quoted for the information of illuminating engineers: Light sand-blasted glass, 12 to 20 per cent; ground-glass, 20 to 30 per cent; opal, 25 to 40 per cent. Usually perfection of scatter goes hand in hand with great absorption but there is no inherent reason why this should be so. No doubt the desirability of economical diffusion of light in interior illumination will lead to great improvements of benefit in photographic work.

**Surface
Absorption**

Before I come to an altogether different property of light-refraction, I ought to say a word on the absorption as distinguished from the reflection, which light undergoes when it falls on different surfaces. It is beyond the scope of this monograph to deal with that property of dark or black surfaces which causes the disappearance of light. It must be sufficient to say that no substance is so black as to absorb all the light which falls on it. The only black is space itself: the blackest surface you can get looks lighter than the mouth of a natural or artificial tunnel since it reflects some light. But many substances reflect very little light, which is to say that they are efficient absorbents of light. Black velvet, for example, reflects about $\frac{1}{2}$ per cent, and I recollect Dr. Mees once saying that a certain black paper used by Belgian undertakers (for what purpose I have completely forgotten and am now at a loss to imagine) reflects still less. But stuffs which you can spread on any surface such as wood or metal, the so-called "dead-blacks," usually reflect more, probably 2 or 3 per cent. Surface reflection is of importance in coloring studio interiors and workrooms.

Camera Linings

These facts caution us that the interior surfaces of a camera necessarily scatter onto the plate some of the light which almost every lens casts upon them, for example, the folds of the camera-bellows. If parts of wood, metal, or canvas have worn bright, the specular reflection from them may be enough to cause definite patches of fog on the plate, often to the great bewilderment of the worker. Generally the reflection will be diffused, and therefore not localized on the plate, but marring the brilliance of negatives by slight general veil.

Refraction An explanation of the refraction or bending of rays of light when they pass from one transparent substance into

another is not such an easy matter. I must ask the reader to prepare himself for a little geometry, with the promise that it shall be very little. Fig. 11 is a diagram representing a ray of light AB, falling obliquely on a plate of glass, shown in section. Observations as long ago as A.D. 150 showed that it does not proceed along its straight-line path to C but at the point B, where it meets the glass, is bent into a new direction. The question is—what is the law according to which it is bent? Though it was known in the early centuries that the degree of bending varied with different substances, it was not until 1626 that a Dutch mathematician, Snellius, discovered the law. Since this law is the basis of all lens-construction, and in fact of almost

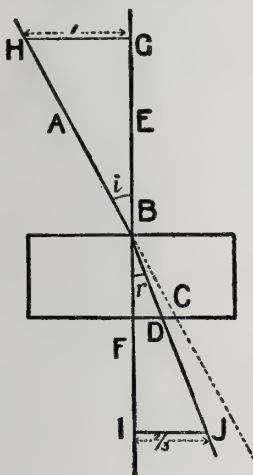


FIG. 11

every optical instrument, it is interesting to understand what it is. As an easy way to that end let us assume that by some kind of second sight we know the course the ray AB will follow, and then see how that fits in

with a rule. So I draw the path BD of the refracted ray in a plate of glass; also imaginary lines BE and BF through the point B and perpendicular to the glass. Just as in the reflection of light, the angle ABE is called the angle of incidence (i), DBF is the angle of refraction (r).*

Now I am going to do something which appears to have nothing to do with our problem, but wait awhile and you will see. At right angles to the perpendicular BE (continued) I will draw the line GH, meeting the original ray AB at H. Next I measure along the other side of B a distance BI equal to BG, and from I draw a line IJ at right angles to B (continued) and two-thirds the length of GH. I shall find that the end of this line, the point J, comes just on the line of the refracted ray BD. Clearly that means that my construction has led me to a point in the path of the refracted ray and now we must see how we can derive a rule from it.

In doing this, notice that the lines
Sines GH and IJ play a similar part in the construction. One faces the angle of incidence i , and the other the angle of refraction r . And you remember that we made the lines BG and BI equal, and that therefore HB and BJ are also equal. Hence it is clear that the lines GH and IJ are relative measures of the two angles which they face. They are, in fact, what mathematicians call the "sines" of the angles. Usually the sine of, say, the angle i would be the ratio of GH to HB and that of angle r HJ to BJ. But as the longer line, or hypotenuse as it is called, is of the same length in each case we can leave it out of account. We have adopted a particular construction whereby we arrive easily at the relative value of the sines without any calculation. Now we can put into words, which will convey a definite meaning to the reader, the law which Snellius discovered. It is that, for a pair of media, e. g., air and glass, the sine of the angle (i) of incidence always bears a certain relation

*Note particularly that angles of incidence, reflection, and refraction are always reckoned from the perpendicular to the surface, not from the surface itself. Thus the more oblique the ray, the greater the angle of incidence. The reader will save himself confusion if he accustoms himself to this system.—G. E. B.

to the sine of the angle (r) of refraction, that is to say, the former is $1\frac{1}{2}$, or $1\frac{1}{3}$, or $1\frac{1}{4}$ times the latter whatever the angle the incident ray makes with the surface.

This ratio is called the index of refraction of the material—in our case glass—in respect to the other material, e. g., air, through which the incident ray traveled. You will recollect that we drew IJ two-thirds the length of GH. Therefore the index of refraction in our example is $1 \div \frac{2}{3}$ which is the same thing as $3 \div 2 = 1\frac{1}{2} = 1.5$. If the index of refraction had been 2, we should have drawn IJ half the length of GH and so should have obtained a path of the refracted ray along a line making a smaller angle with the perpendicular than does BD. In short, we must accustom ourselves to the idea that a figure for a given index of refraction represents the size of the sine of the angle of incidence when that of the angle of refraction is 1, and when the ray is passing from the rarer to the denser medium. The other way about, if the ray is passing from the denser to the rarer medium. If you keep that clearly in mind, refraction becomes a simple matter. Note also the two rules which follow.

**Refraction
Facts**

The index of refraction of most substances, e. g., water, glass, etc., is more than 1.

When light passes into such a substance it is bent toward the normal, as BD, Fig. 11.

When, on the other hand, light passes from such a substance into air it is bent away from the normal.

The angle of refraction in this latter case is easily drawn by remembering that the figure for the refractive index of the solid substance then represents the size of the sine of the angle of refraction when that of the angle of incidence is equal to 1.

From this it follows that when a ray of light falls obliquely on a glass plate, the two sides of which are parallel, it is bent *toward* the normal when it enters and then *away from* the normal by an equal amount when it emerges. Thus the net result of the two successive refractions is to shift the ray parallel to itself. The thicker the plate the greater the displacement of the ray.

A Rule for Drawing

Let me illustrate this point and at the same time show how an ordinary ruler and compasses permit of our exactly tracing the course of a ray through any series of refractions. Suppose a ray AB (Fig. 12) falls upon the thick glass plate at B.

If it went straight on unrefracted its course would be ABC. But we know it will be bent twice to an amount depending on its angle with the surface and on the refractive index of the glass, say 1.5. First, to trace its course at the first refraction, i. e., in the glass. From center B strike two circles DE and FG whose radii are in proportion of 1.5 to 1, that is,

if the outer is 1.5 inch the inner is 1 inch, or they may be 3 and 2, $4\frac{1}{2}$ and 3, any radii so long as they are in this proportion. Through the point where the ray cuts the circle of *smaller* radius draw a line perpendicular to the surface of the plate. Continue this line HI to meet the outer circle in J. Then the line JB, if continued into the plate, is the path of the refracted ray, i. e., BK.

The same construction (reversed) would enable us to obtain the new path of the ray BK on its emergence from the glass into the air, but the course is obtained much more simply by drawing a line from K parallel to the original ray AB, for, as we have already seen, the refractive effect of a flat plate with parallel surfaces is to shift rays parallel to themselves.

Light-Filter and Focus

Now let us use what we have learned to examine a case of practical importance, viz., the effect of a light-filter on the sharp focus of rays forming a picture on the plate. In Fig. 13, in order not to waste space, I show one only of the pair of rays passing through a diaphragm to form an image on the plate at C, where it

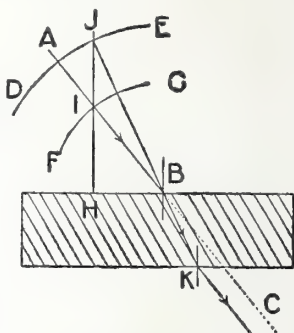


FIG. 12

joins all the other rays from the same point of the subject which come through a stop of diameter double that of AB. Suppose, however, we interpose a light-filter DE, shown very thick for clearness; what happens to the ray BC and equally to every other ray coming through the diaphragm? In accordance with the method of Fig. 12 it is bent at F and G and emerges parallel to BC but shifted a little toward the edge of the

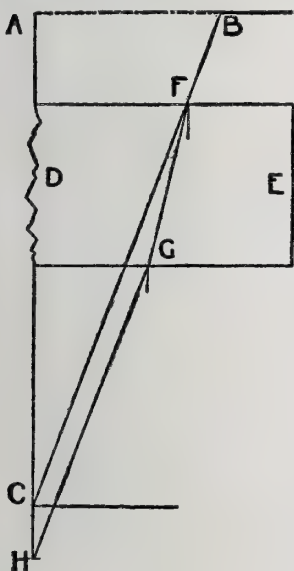


FIG. 13

filter and thus meets the central (unrefracted) ray at H instead of at C.

Since this applies to other rays, the whole image-point or disc is at H. By drawing the refracted rays in accordance with an index of refraction of 1.5 it will be found that the backward displacement of H is exactly one-third the thickness of the filter, and this holds good for any position of the filter and for any angle of the rays. It means, of course, that if we focus without the filter and then insert it before exposing the plate, the picture will be out of focus. The degree to which it will be out of focus depends on the

thickness of the plate and the angle of the cone of rays forming the image-point.

I have made this latter very large (something like $f/1$) in order to show a large shift [backward: with a lens of smaller aperture the backward displacement will be the same but its effect is diminished by the narrower angle of the pencils of rays which form the image; just as in ordinary focusing of the picture, when

you are using a small stop, the picture does not quickly get out of focus with the slightest turn of the focusing-pinion. This setting back of the focus takes place even when a plate is reversed in the holder and exposed glass-side to the front, although then the displacement (one-third the thickness of the glass) is usually too slight to be of any moment. Moreover it is automatically compensated for by reversing the focusing-screen in its frame, providing that the plate and focusing-screen are the same thickness. In any event, displacement of focus due to difference of thickness will be so small as to be negligible.

**Reflection
and
Refraction**

In studying all this explanation of refraction I hope the reader has noticed an omission: he ought to have done so if he has kept in mind the previous paragraph on reflection. At any rate, look back at Fig. 11 and it will be seen at once that it does not show any reflection of the ray AB from the first surface of the glass and of the refracted ray BD from the second surface. But we have already learned that part of the light is reflected even by a transparent substance, according to our familiar law that the angle of incidence is equal to the angle of reflection. Thus, whenever light passes from one substance into another which is optically different (i. e., of different refractive power) there is always reflection as well as refraction. The two go hand in hand. So long as the light continues to travel through a medium of the same refractive index the rays of light continue to traverse the path which they took on entering the medium. The latter may actually consist of two different substances but that, if the refractive index of each is the same, makes no difference: optically they form one substance. But at the bounding surface, the two actions (reflection and refraction) come into play again. To this there is an exception which we must look at it closely.

**Reflection
within
Surfaces**

The exception concerns rays which, traveling in any substance such as glass, reach the surface which separates them from the surrounding medium—air or anything else. As we have just been reminded,

such a ray AB (Fig. 14) entering the glass plate at an angle of refraction r , is divided into two parts. When it meets the opposite surface at B the major part is refracted to C instead of passing straight on to D, whilst a small part is reflected to E.

Of course the action is repeated again at E as at B, but the proportion of light which in the first instance is reflected, as compared with that which is refracted, is so small that we may leave any further sub-division out of account.

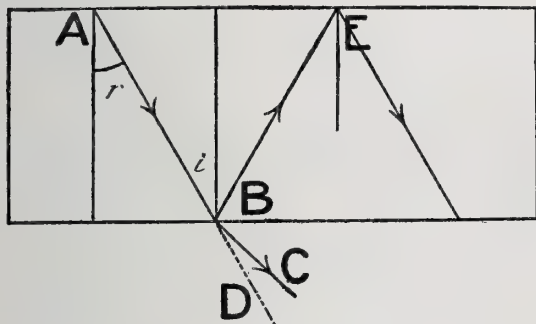


FIG. 14

But now think what will happen as the ray AB enters more and more obliquely, that is as the angle i becomes greater. Clearly we reach a point at which the maximum refraction is produced: the ray AB instead of following a course such as BC in the surrounding medium, is so bent that it passes along the surface of the glass. In other words its angle of refraction is 90° . It cannot be refracted more than this, and thus if the ray AB falls a little more obliquely (Fig. 15) it is no longer divided into a refracted and a reflected portion but the whole is reflected along BE. In actual experiment the light received at E is seen to jump up suddenly in intensity as this degree of obliquity of AB is reached or overstepped. The angle i at which refraction ceases and total reflection takes place is called the "critical" angle. For crown glass of refraction

tive index 1.5 it is just under 42° , which means that any rays which meet the second surface of a glass plate at an angle of incidence of 42° or more are totally

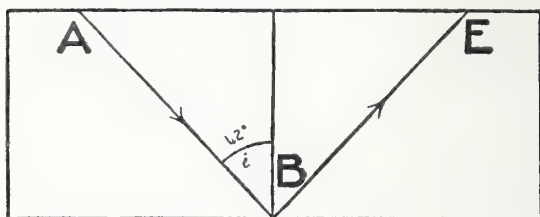


FIG. 15

reflected according to our law of equality of angles of incidence and reflection. You have the remarkable phenomenon of highly perfect reflection without any mirror surface.

Reversing Prism

This notable property of refraction from a dense into a rarer medium is used in the design of the total-reflection prism commonly fixed to the lens of a photo-engraver's camera, in order to allow of the original being spread flat below it and at the same time of securing a negative which is reversed as regards right and left.

Such a prism consists of a block of glass of triangular section, one angle being 90° and the other two each 45° . Rays falling at right angles to one small face of the prism as AB and CD (Fig. 16) meet the back surface at 45° (i. e., more than the critical angle) and therefore are reflected at an angle of 45° to DE,

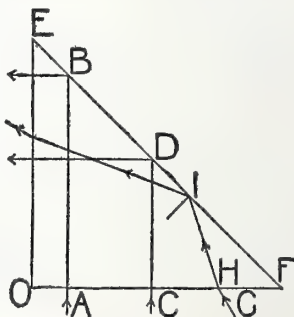


FIG. 16

that is, at right angles to their original path. Rays such as GH which strike the surface of the prism ob-

liquely are refracted equally and in opposite directions on entering and emerging and are totally reflected at the surface FE if they meet the latter at an angle equal to or more than the critical angle. But in thus using a total-reflection prism for delivering rays from an object to a lens along a path, as though the object were in front of the lens instead of vertically below, it follows that many rays reach the surface FE at less than the critical angle. Opticians therefore silver this surface and so enhance its reflecting power above that which a prism of transparent glass possesses.

It must also be pointed out that the prism requires to be of size sufficient to allow rays reaching it over a required angle of view to arrive at the surface EF with only the one alteration in their course occasioned by the refraction at the surface OF. If too small, light is refracted to the lens at the surface OE or reflected by this latter and re-reflected from EF, in either case causing ghost or glare images on the plate.

Erecting-Prism

The total-reflection prism is used in another way for the purpose of producing not a laterally reversed image in a direction at right angles but inversion of the image along the same path. This it does if placed in the position shown in Fig. 17,



FIG. 17

in which the arrows show how successive refractions and reflection bring the upper rays below and *vice versa*. This device is used in front of a projecting lantern when

it is required to avoid the inversion on the screen of, say, some experimental apparatus in the lantern stage.

Approaching the end of the study which the space of this monograph permits, we come again to halation.

It appropriately rounds off the field of our inquiry, since the three things we have looked at—refraction, and regular and diffused reflection—are all concerned in the spreading of light action called halation.

Let us put the conditions under the microscope by

And the preventive? Clearly it may take several forms: (1) A transparent instead of a turbid emulsion; hence no scatter of rays as at A: not a practical proposition at present. (2) A light-stopping film between emulsion and glass either of slow emulsion or of some coloring film between emulsion and glass either of slow emulsion or of some coloring matter: both used commercially to some extent and very effective. (3) A coating on the back of the glass of the same refractive index but also absorbent of the chemically active rays. The third preventive is the familiar anti-halation backing for which scores of formulæ have been given. The two things just mentioned which really matter are often overlooked. The backing should be of the same refractive index in order that rays may pass uninterruptedly (without reflection) and become absorbed. If the backing allows this, it may be perfectly transparent, whilst none the less effective. A matt opaque backing cannot from its nature allow rays to penetrate: what it does not absorb at its surface it scatters back to the film. Recognition of this fact has led within the last few years to highly effective and at the same time very convenient backing of dry-plates by their manufacturers.

We have in reality traveled a very
Conclusion little way in exploring the sphere of light in photography, and have not been able to reach the more complex phenomena which play a part in color-photography or in the design of photographic lenses. Perhaps I have stepped aside too often to point out applications of the elementary laws: perhaps have been too anxious to make these latter clear even at the risk of repetition. At any rate, I hope I have encouraged the reader to look below the surface of photographic operations and to obtain a first sight of the real facts and principles upon which they rest. It should be obvious that such a conception of what one is doing necessarily adds tenfold to one's interest in photography and is bound to contribute to one's success.

GEORGE E. BROWN.

BOOKS

Few books on light are easy reading or treat the subject without a good deal of mathematics. Two which can be recommended are the following, although both are probably out of print and only obtainable second-hand.

Optics without Mathematics. By T. W. Webb, M.A. London Society for Promoting Christian Knowledge. E. & J.B. Young & Co., New York.

The Nature of Light. By Dr. Eugene Lommel. Routledge & Co., London, 1895.

Notes and Comment

In spite of the difficulties of war times, the Exhibition of the Royal Photographic Society, now open in London, is reported to be quite equal in the quality and variety of work shown to the exhibitions of past years. The exhibits are shown in three sections—pictorial, color, and scientific. This year the Society has revived the custom of giving medals, five being awarded in the pictorial section (one to Alice Choate of New York City); four in the department of color photography (all autochromes), and two in the scientific and technical section.

American photography is fairly well represented in all the sections, being especially strong in the scientific and technical department. The portraiture of the year, according to the critics, is notable for its saneness and quietness. One of the best examples of this is a home portrait by an American worker, C. Peabody, of Cambridge, Mass. As always, Alvin Langdon Coburn shows examples of his recent work, which receives high praise from the reviewers. The Hoover Art Company, of California, sends a series of six heads of young women, described as "A Galaxy of Los Angeles Youth and Beauty." Pirie MacDonald does not seem to have exhibited this year.

In the scientific section, astronomical photography is chiefly represented by work from this country and from the College of the English Jesuits at Stonyhurst. An interesting exhibit is a series of color transparencies of Saturn and Jupiter, by the Kodachrome process, sent by Prof. R. W. Wood of the Johns Hopkins University, Baltimore. The exhibits of aëro photographs from the war front, photo-micrography, radiography, natural history, and process work, are notable.

Among the printing processes used the bromide process leads, with platinum second. The oil and gum methods seem to be losing favor.

In "The Inland Printer" for September, Mr. Stephen H. Horgan, the well-known authority on process work and graphic arts, has an interesting paper upon the degenerate German in modern pictorial poster work. Germany has produced some remarkably clever and attractive poster work in the last ten years, but the particular variety foisted upon this country and still disfiguring our subway stations and public buildings well deserves the caustic handling which it receives at Mr. Horgan's hands. The paper is abundantly illustrated with examples which are to the point and convincing.

Some time ago I commended in these pages the notable achievement in hand-camera making, introduced under the name Auto-Fixt-Focus hand camera, by the Herbert & Huesgen Co., 18 East 42nd Street, New York. This camera is now in the market and may be seen at most dealer's. Representing many distinct advances in hand-camera construction, it should not be overlooked. If your dealer cannot show it to you, send to the makers for the illustrated leaflet which describes the camera very fully and illustrates its various movements.

American-made developers for plates, films, and papers, replacing the European developers, are now coming into the market in many varieties. Caltone, introduced by the Berlin Aniline Works, 213 Water Street, New York, is said to offer a perfect substitute for Metol. It has been used by some of the largest consumers in the country for the past six months and its increasing sales show that it fulfils the claims made for it. Fredol is a new developing agent similar in composition and characteristics to Metol, announced by Burke & James, Inc., of Chicago. Using the standard formula, Fredol gives 40 ounces of developer for gas-light papers at a cost of 17½ cents, this economy and use being a special feature of this developer. Diamidophenol, said to be identical with amidol, is made by

Brewster & Robbins, of South River, N. J. It is an all-round developing agent, giving equally good results with the various papers, plates, and films on the market. Paramidophenol (Hydrochloric-Edison) comes from G. Gennert, New York and Chicago, and has the guarantee of this well-known house behind it. It may be used in place of metol in all the usual metol formulas for plates, films, and papers. There are other new developers, of which more later, but these I can vouch for as being thoroughly satisfactory and reliable.

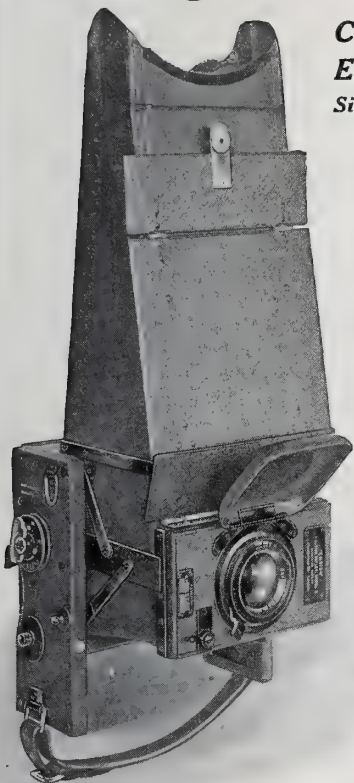
As the result of much patient labor, we have accumulated a supply of out-of-print numbers of **THE PHOTO-MINIATURE** for the accommodation of readers of the magazine needing back issues to complete their sets, or who want them for their information on specific subjects. In most instances there are only two or three copies of each out-of-print number. The price is 25 cents per copy, postfree. Those who want copies should send in their orders at once as the supply on hand will quickly disappear. A complete set of **THE PHOTO-MINIATURE** is the most comprehensive and most satisfactory library of photographic information in the English language.

J. F. Johnston, P. O. Box 578, Rochester, N. Y., the manufacturer of Snow White Water-Color, has prepared a special demonstration card showing the uses, quality, and efficiency of Snow White as a marking fluid for titles, signatures, or decorative work in albums or on dark mounts and as a negative opaque. This demonstration card, with descriptive booklet on the use of Snow White, will be sent free to any reader of **THE PHOTO-MINIATURE** who will ask for it, mentioning this note. Snow White is a remarkable product and I hope that Mr. Johnston will be overwhelmed with requests for the card which shows what it will do. A generous sample of Snow White can be had, postfree, by enclosing 25 cents when you write.

The California Camera Club, San Francisco, announces the Fifth International Photographic Salon, to be held in the galleries of the Palace Hotel, San Francisco, November 25 to December 2. Prints should be mounted but not framed, and should reach the Club before November 4 next. Copies of the Prospectus can be obtained from the Secretary, 833 Market Street, San Francisco, Cal.

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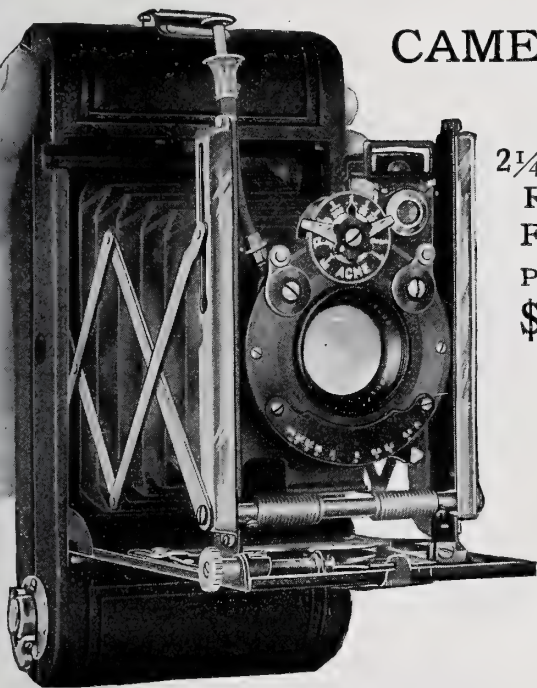
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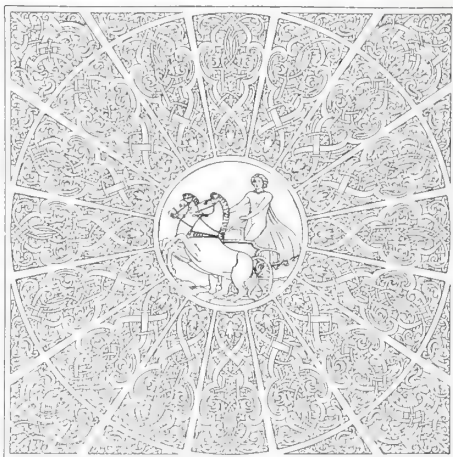
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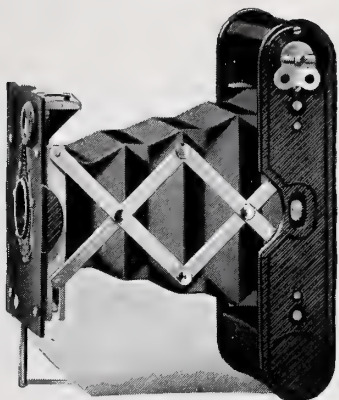
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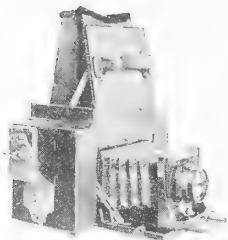
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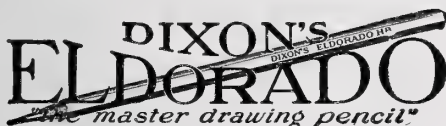
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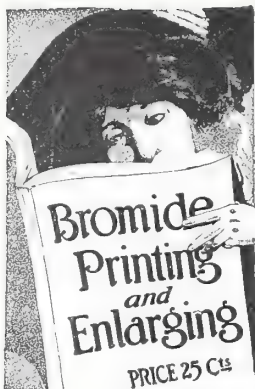
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